FISHERY DATA SERIES NO. 103

CREEL STATISTICS FOR THE VALDEZ ARM AND ESHAMY BAY SPORT FISHERIES OF PRINCE WILLIAM SOUND, ALASKA, DURING 1988[1]

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April 1989

[1] This information was partially financed by the Federal Aid in Sport Fish Restoration Act (16 U.S.C. 777-777K) under Project F-10-4, Job Number S-22-1.

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ABSTRACT

Roving creel surveys were conducted to estimate sport effort and harvest of coho salmon *Oncorhynchus kisutch*, pink salmon *Oncorhynchus gorbuscha*, and halibut *Hippoglossus stenolepis* in the marine and shore fisheries of Valdez Arm from 1 July through 15 September 1988; and effort for and catch and harvest of sockeye *Oncorhynchus nerka* and pink salmon in the Eshamy Lagoon sport fishery from 10 July through 7 September 1988. These surveys estimated that boat anglers expended 4,062 boat-trips in Valdez Arm and shore anglers in Valdez Arm expended an estimated 33,187 angler-hours of effort during this survey period. The combined effort resulted in the harvest (fish kept) of 8,450 coho salmon, 20,167 pink salmon, and 1,512 halibut. In Eshamy Lagoon, anglers expended 2,572 angler-hours of effort during the survey period to catch (fish kept plus fish released) 1,238 sockeye salmon. Anglers harvested (kept) 77.5 percent (959) of the sockeye salmon caught. Anglers released 96.3 percent of the 2,190 pink salmon caught in Eshamy Lagoon during 1988.

KEY WORDS: creel survey, Valdez Arm, Eshamy Lagoon, Prince William Sound, sockeye salmon, *Oncorhynchus nerka*, coho salmon, *Oncorhynchus kisutch*, pink salmon, *Oncorhynchus gorbuscha*, halibut, *Hippoglossus stenolepis*, catch, harvest, effort.

INTRODUCTION

Prince William Sound (PWS) is located in southcentral Alaska (Figure 1). The marine and fresh waters of the sound support a variety of fishery stocks that are increasingly being targeted by sport anglers. From 1984 through 1987, the numbers of sport anglers fishing PWS waters has increased 160% (Mills 1988). Most of this increase has occurred in two areas: Valdez Arm and Eshamy.

Valdez

Valdez Arm supports the largest sport fishery in Prince William Sound (Mills 1988). Valdez, a community of 3,600 people located at Mile 0 of the Richardson Highway, provides access to and services for the sport fisheries in Valdez Arm (Figure 2). The fishery for pink salmon *Oncorhynchus gorbuscha* has held local importance for many years. Beginning in 1985, the dramatic growth of this fishery has made it the largest sport fishery for this species in the state (Mills 1988). Valdez Arm also supports the largest and most consistent sport fisheries in PWS for coho salmon *O. kisutch*, halibut *Hippoglossus stenolepis*, numerous species of rockfish *Sebastes sp.*, and Dolly Varden *Salvelinus malma*.

During the years 1980 through 1984, Valdez Arm supported an average of 17,100 angler-days of sport fishing effort annually (Mills 1981-1985) (Figure 3). Effort increased to an average of 40,100 angler-days for the years 1985 through 1987 (Mills 1986-1988). Most of the increase in effort can be attributed to recent successes in pink salmon production by the Valdez Fisheries Development Association's (VFDA) Solomon Gulch Hatchery. Prior to returns of stocked fish beginning in 1985, sport harvests of pink salmon in Valdez Arm averaged nearly 10,200 fish annually. Since 1985, the annual harvest of pink salmon has averaged just over 25,000 fish, or 84.1% of the total annual harvest of pink salmon in PWS (Figure 4). In addition, VFDA-produced coho salmon, and to a lesser degree chinook salmon *O. tshawytscha*, began contributing to the Valdez Arm fisheries in 1987. The direct effect of these productions has been the creation of an intensive shoreline and nearshore marine fishery in Valdez Arm. The increased effort has expanded the market for the charter boat industry in Valdez.

In addition to the sport fisheries, PWS also supports intensive commercial fisheries that compete for the area's stocks of pink and coho salmon and halibut. Management of pink and coho salmon stocks is complicated by the presence of both hatchery and wild stocks. Allocation of coho salmon and halibut stocks and the timing of commercial pink salmon openings in Port Valdez have become controversial issues in recent years because of the steady increase in the sport fishing effort operating out of Port Valdez. The average harvest of coho salmon in Valdez Arm has risen from 4,700 fish annually during the years 1980 through 1984 to 7,600 fish annually for the years 1985 through 1987 (Mills 1981-1988) (Figure 5). Since 1985, Valdez Arm has supported an average of 51.6% of the total PWS coho salmon sport harvest. Similarly, the average harvest of halibut in Valdez Arm has risen from 1,500 fish annually from 1980 through 1984 to 2,900 fish annually from 1985 through

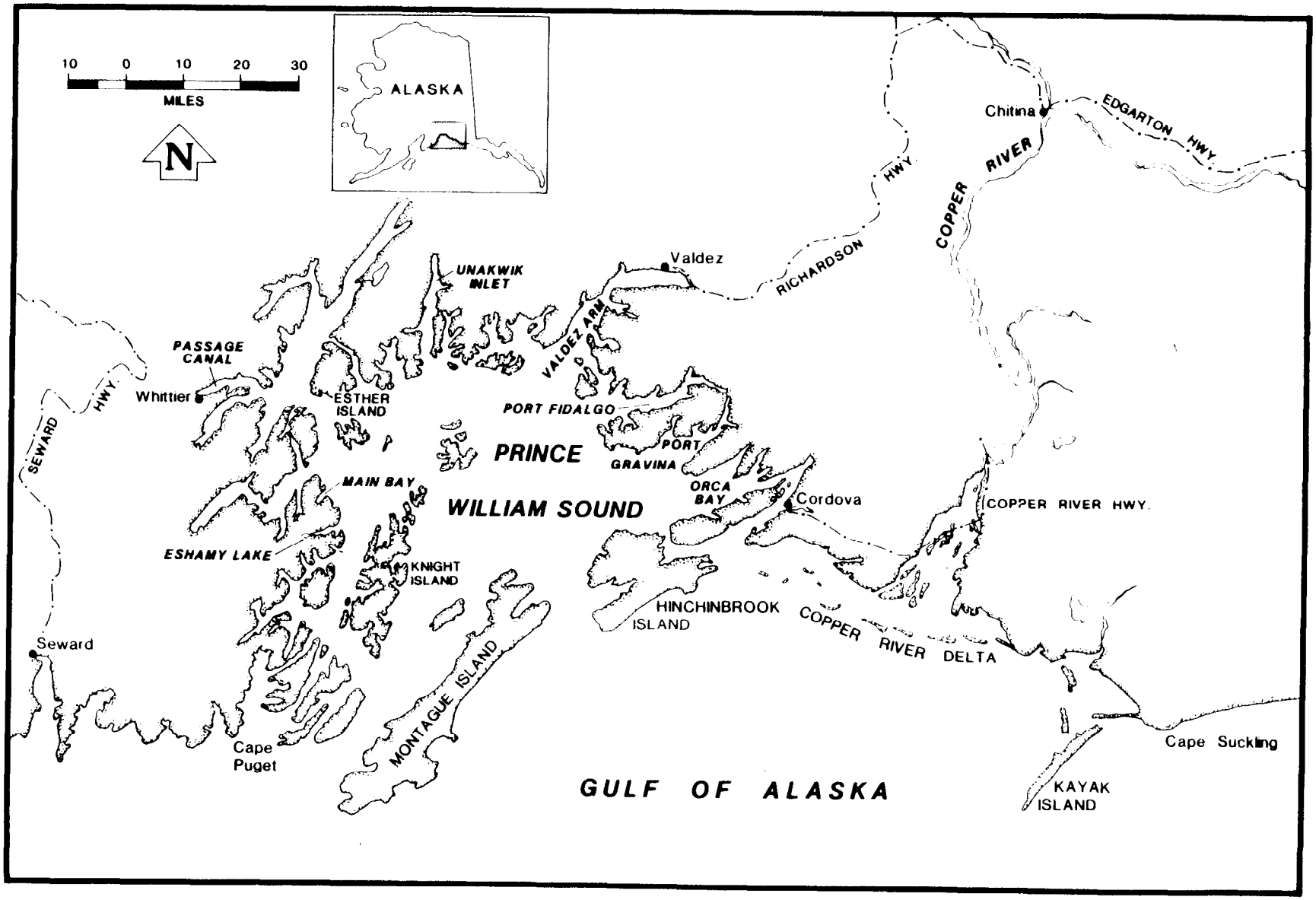

Figure 1. Map of Prince William Sound.

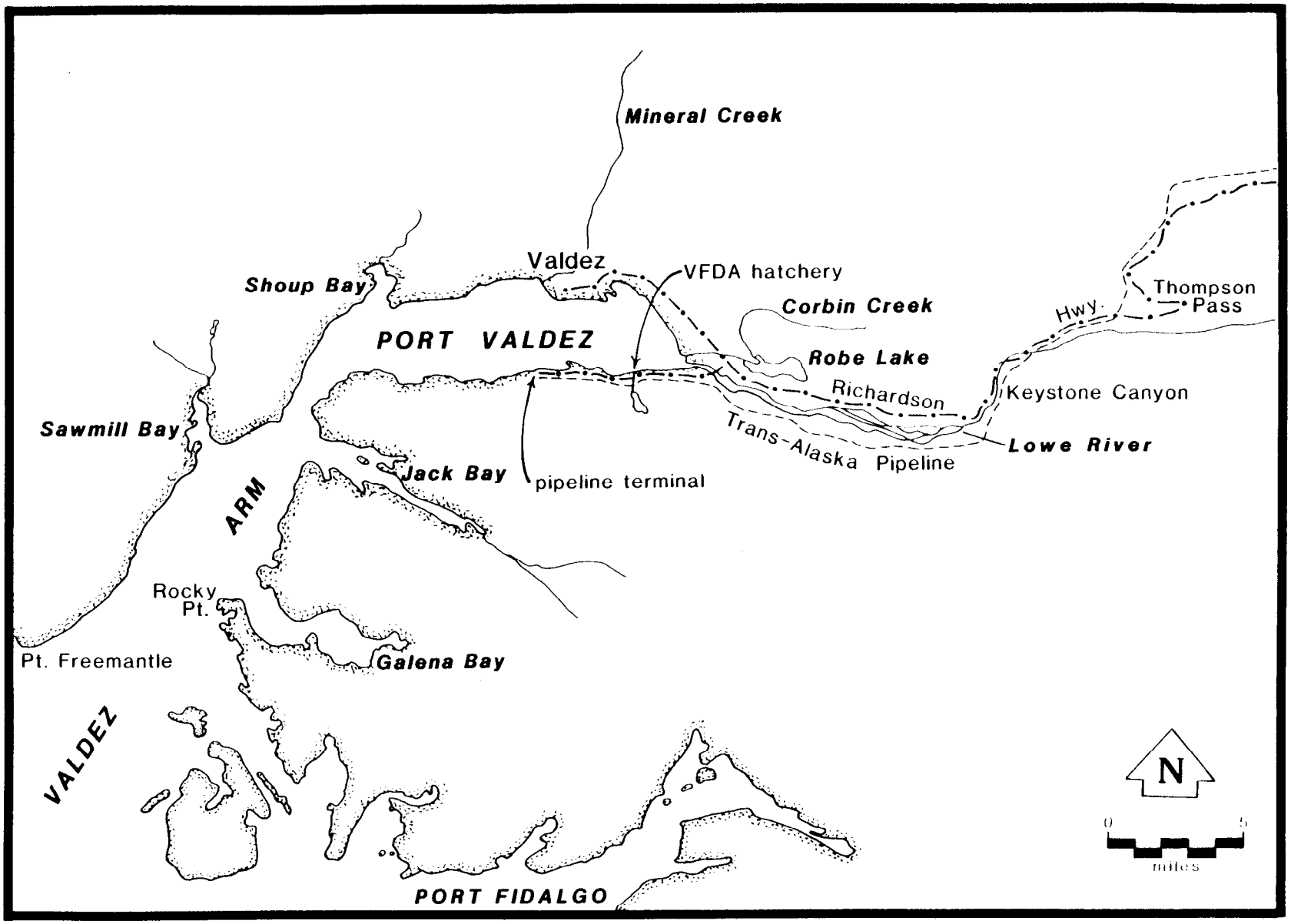

Figure 2. Map of Valdez Arm.

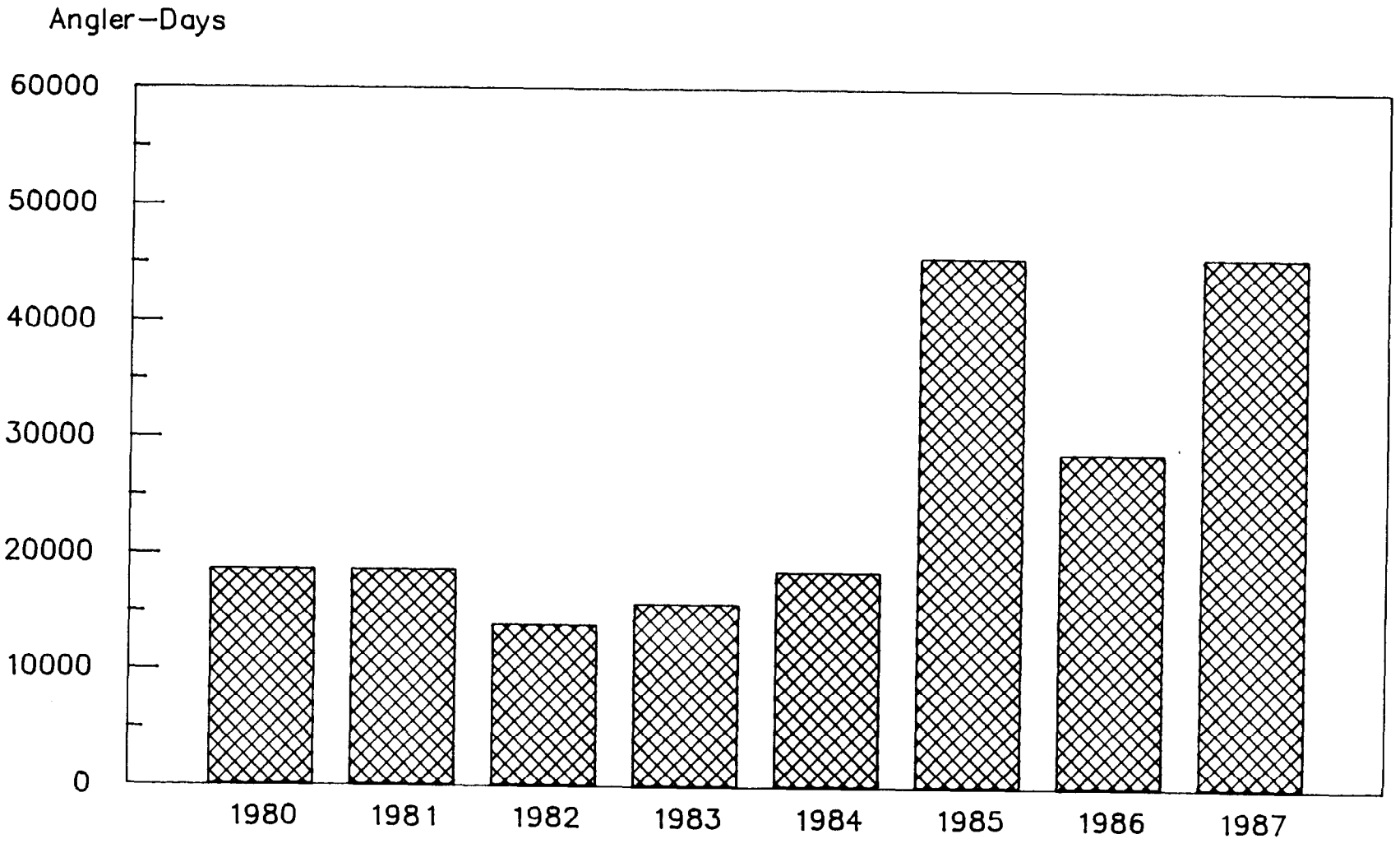

Figure 3. Sport effort in Valdez Arm during the years 1980 through 1987.

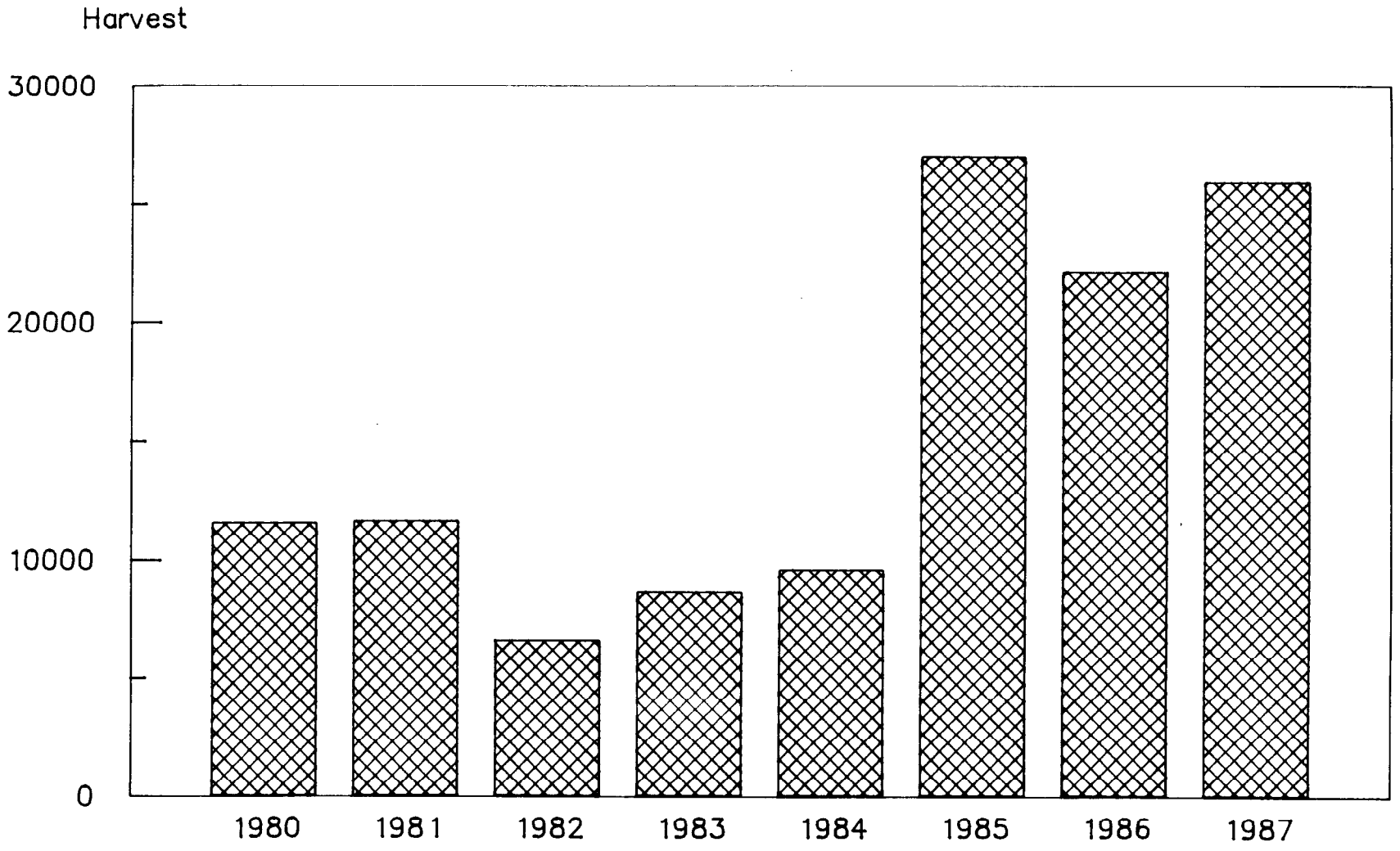

Figure 4. Sport harvest of pink salmon in Valdez Arm during the years 1980 through 1987.

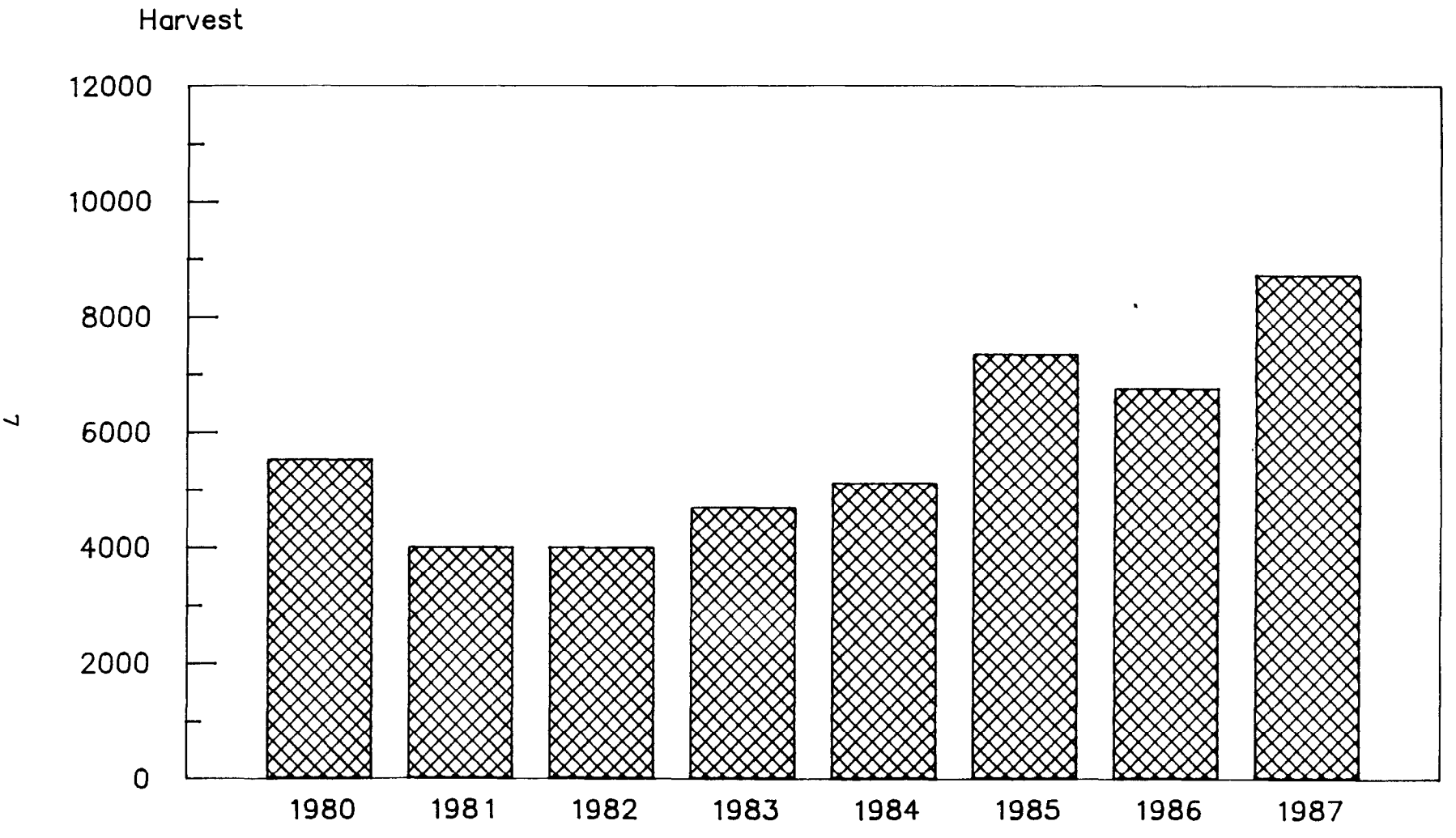

Figure 5. Sport harvest of coho salmon in Valdez Arm during the years 1980 through 1987.

1987 and now accounts for 26.6% of the total PWS halibut harvest (Mills 1981-1988).

The private and charter components of the Valdez Arm sport fisheries are expected to continue expanding in both effort and harvest. To provide the Board of Fisheries the necessary baseline data upon which allocative decisions can be made regarding the area's fisheries stocks, it is necessary that the Department have a thorough understanding of all the fisheries involved. For the sport fisheries, it is imperative that effort, harvest, and stock status data be collected given the expected continued growth of this fishery. For this reason, a creel survey of the sport fisheries was implemented to provide a meaningful data base of fishery statistics. Data from these efforts will provide quantitative baseline information needed to determine the present levels of effort and harvest of coho salmon, pink salmon, and halibut. This information will allow for effective management of the sport fisheries of Valdez Arm and insure for the long-term protection of the area's fisheries stocks.

Eshamy

Eshamy Bay (Figure 6) supports one of the most important sockeye salmon stocks of western PWS. The lagoon and lake areas of the Eshamy system are one of the few terminal destination points where sport fishermen can harvest sockeye salmon in western PWS. Sport fishermen access the area either by boat out of Whittier or by float plane from Anchorage or the Kenai Peninsula. Effort in the sport fishery has been relatively stable since 1980, averaging nearly 1,000 angler-days annually (Mills 1981-1988) (Figure 7).

The sockeye salmon stocks of Eshamy Bay are considered to be in a depressed condition. Escapement goals have only been obtained roughly one out of every four years due to over-exploitation by various commercial fisheries. The primary commercial harvester of Eshamy sockeye salmon stocks is the purse seine fishery of the southwest district of Prince William Sound (Brady et al. 1988). In addition, a smaller but significant gill net fishery targets the stocks as they enter the Eshamy subdistrict of the southwest district. This gill net fishery remains closed whenever escapement goals are not met. In recent years, this has lead to concern that the sport fishery targeting Eshamy sockeye salmon stocks should be concurrently restricted or closed. Although escapement levels have fluctuated substantially since 1980, sport harvests have remained relatively stable, averaging just over 600 fish annually since 1980 (Mills 1981-1988) (Figure 8).

Current commercial fisheries management strategy calls for more consistent escapement and therefore increased numbers of fish available to sport anglers. However, it could be a number of years before escapement goals are regularly achieved, and during low return years, the gill net subdistrict will remain closed. For this reason, it is imperative to obtain estimates of sport fishing effort and harvest of sockeye salmon. This information will assure that the sport harvest does not jeopardize the recovery of this stock.

The objectives of this report are to present: (1) estimates of angler-effort and harvest (number of fish kept by anglers) of coho and pink salmon and

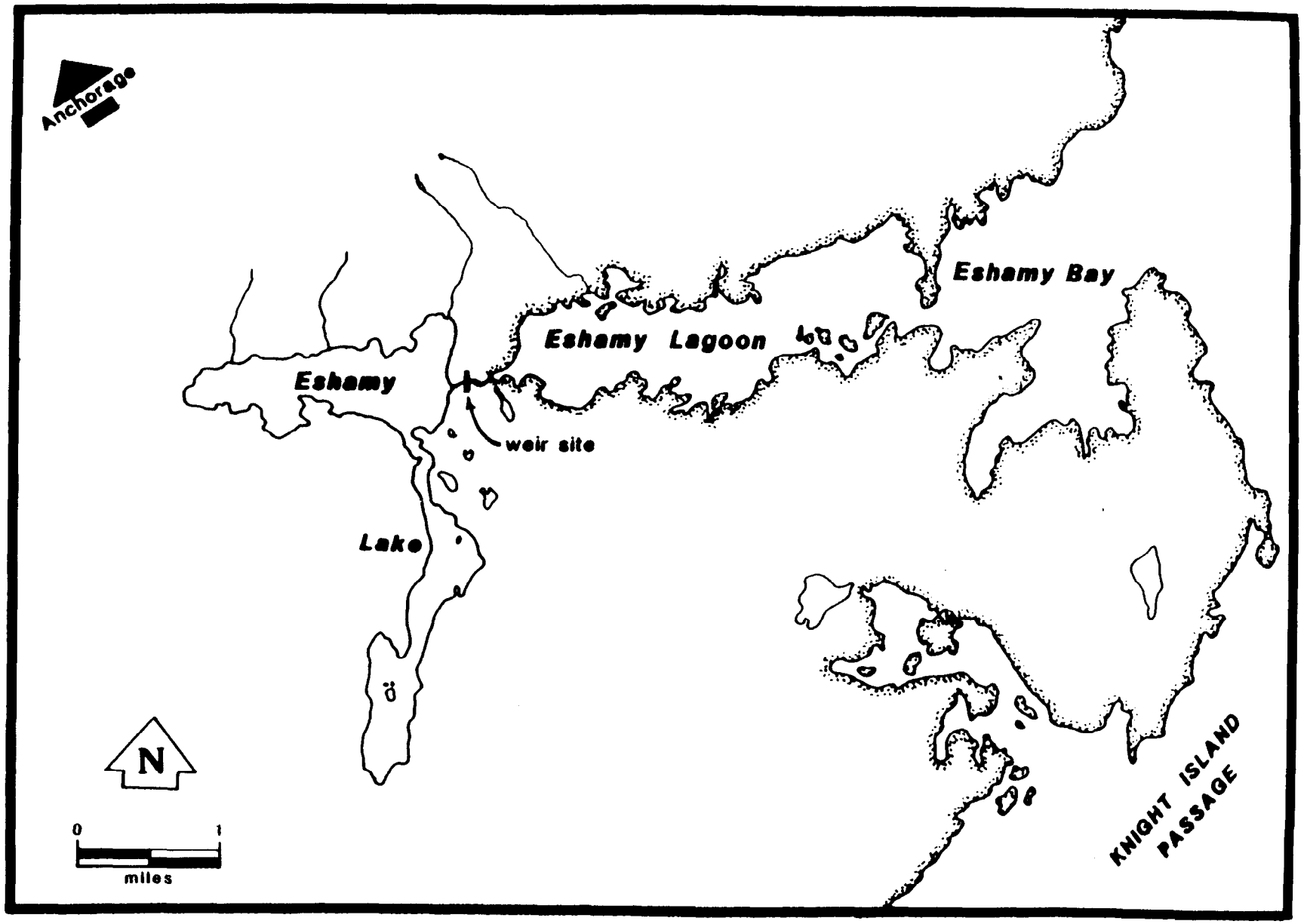

Figure 6. Map of Eshamy Lagoon.

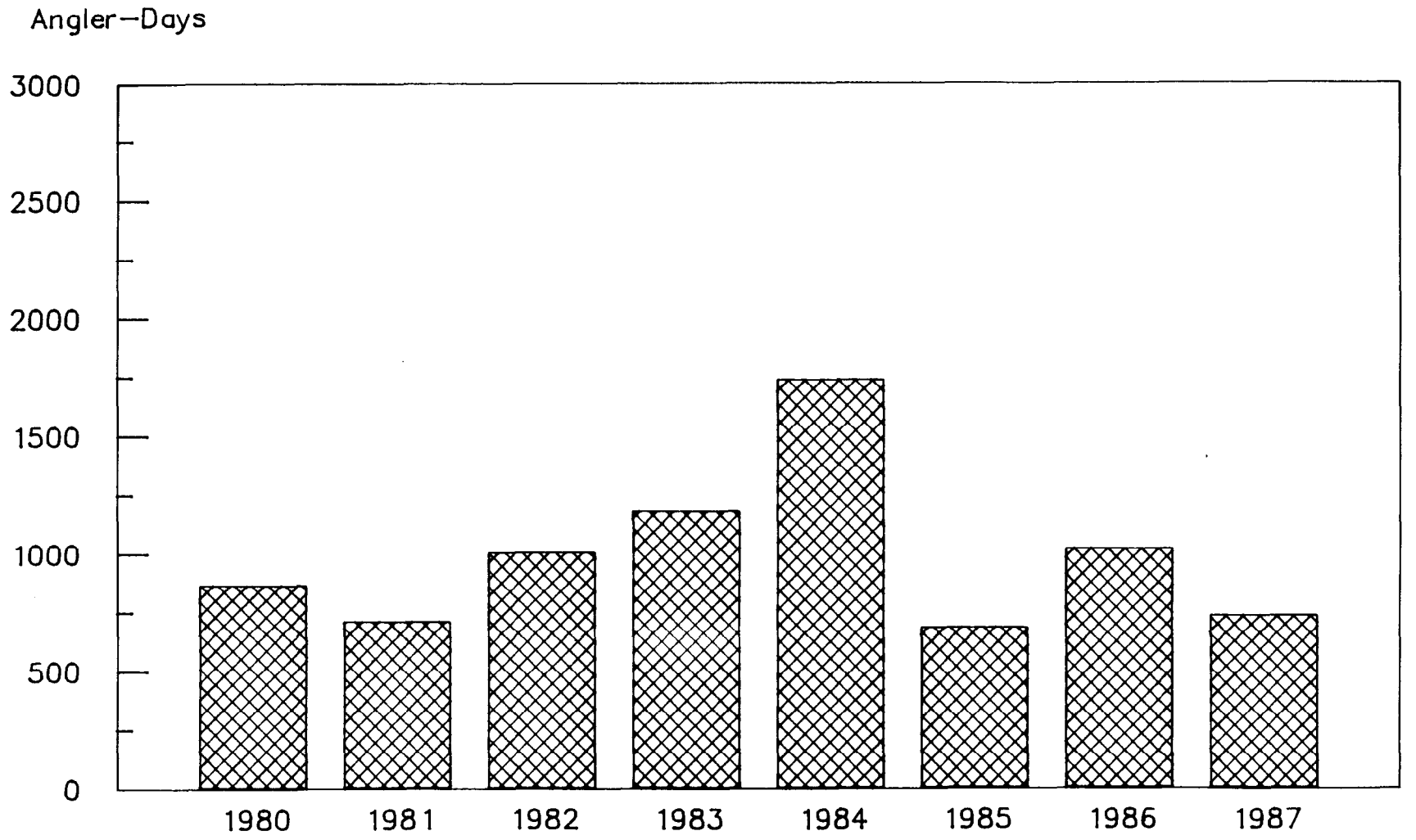

Figure 7. Sport effort in Eshamy during the years 1980 through 1987.

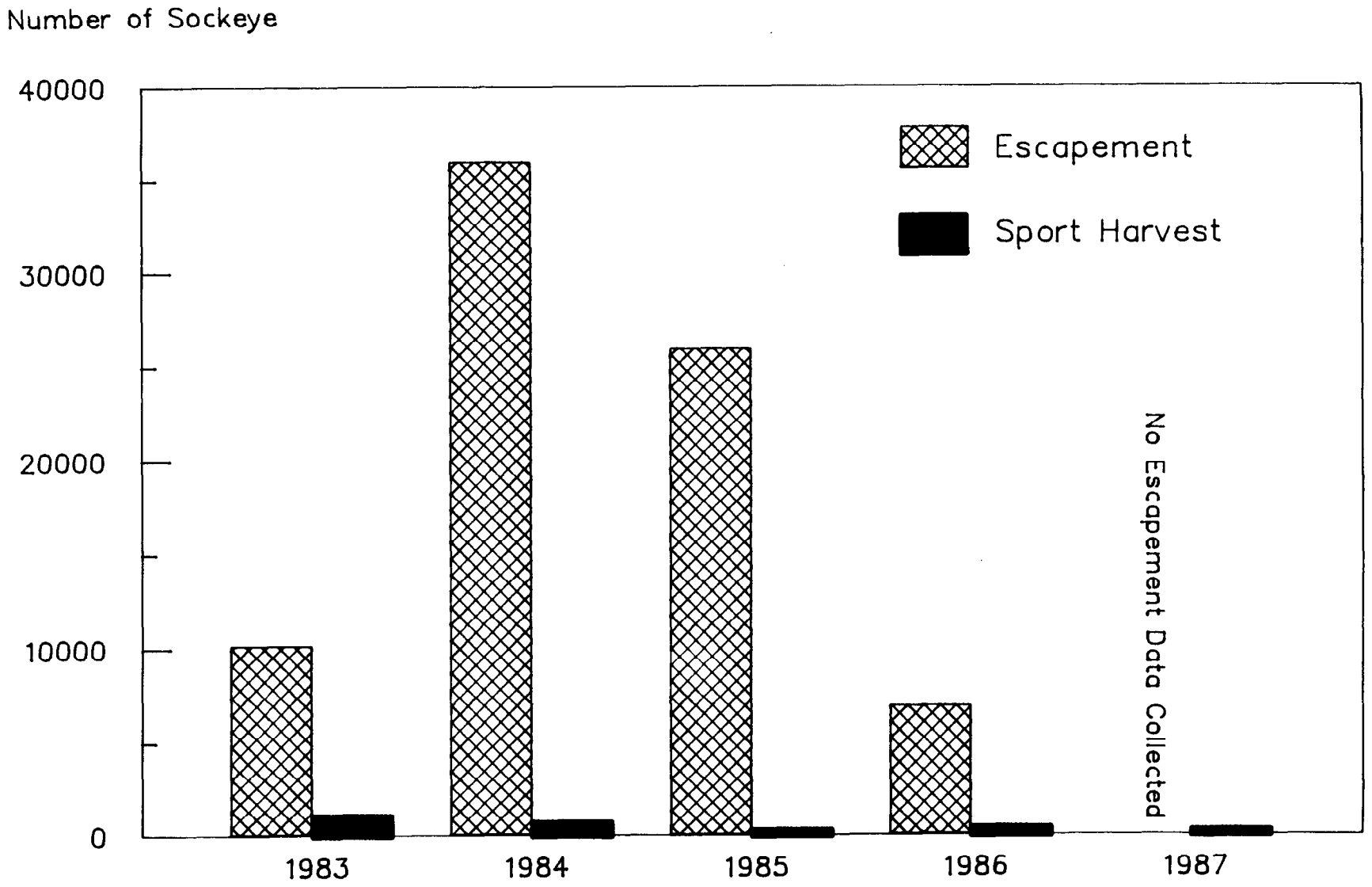

Figure 8. Comparison of the sport harvest and escapement of sockeye salmon at Eshamy, 1983 through 1987

harvest and catch (number of fish kept plus those released by anglers) of halibut in the boat and shore fisheries of Valdez Arm, (2) estimates of the hatchery contribution of coho salmon to the Valdez Arm sport fishery, and (3) estimates of angler-effort and harvest and catch of sockeye and pink salmon in the sport fishery of Eshamy Lagoon.

METHODS

Valdez Creel Survey

A stratified random creel survey was conducted to estimate effort for and harvest of coho and pink salmon and harvest and catch of halibut in the Valdez Arm sport fishery. The survey consisted of two components: (1) a survey of the boat fishery conducted at the Valdez harbor from 1 July through 5 September, and (2) a survey of the shore fishery conducted at the Allison Point and Valdez breakwater beaches from 1 July through 15 September.

Boat Fishery:

A stratified random sample design was used to estimate effort, harvest of coho and pink salmon, and harvest and catch of halibut in the Valdez Arm boat sport fishery. Days were stratified into four 3.5-hour periods (A: 0800-1130 hrs, B: 1131-1500 hrs, C: 1501-1830 hrs, and D: 1831-2200 hrs). All weekend/holiday days and 3 of the 5 weekday days were sampled each week. The weekdays not sampled were selected by randomly choosing 1 weekday and then randomly choosing the day before or after it. Two 3.5-hour sample units were randomly selected, without replacement, within each day. Because this was a newly surveyed fishery and use patterns had not been established, allocation of sampling effort was evenly distributed among the four periods.

For the period through 11 July, counts of all returning boats were conducted at the same time that the angler interviews were done. Due to the difficulty in counting all returning boats while simultaneously conducting angler interviews, each sampling period during the boat survey after 11 July was divided into two 1.75-hour segments. During each period, counts of returning boats were conducted during one of the two segments and interviews were conducted during the remaining segment. Counts and interviews were conducted in a random order which was determined prior to each sample period. Counts after 11 July of all boats returning to the survey area during the segment were doubled to represent the total boat count for that sampling period. These adjusted counts were then used to estimate fishing effort in units of boat-trips.

Interviews of boat anglers were used to estimate harvest rates (number of fish per boat-trip) of coho and pink salmon and harvest and catch rates of halibut. For each returning boat, the following information was collected:

1. the number of anglers in the boat,
2. the number of hours fished,
3. the number of pink and coho salmon harvested,

4. the number of halibut caught and harvested, and
5. whether or not the boat was chartered.

All interviews were completed-trip interviews. Interviews for effort, harvest, and catch rate information were party interviews for all anglers in a returning boat.

Effort and its variance were estimated separately for the weekday and weekend/holiday components of the fishery. The number of boat-trips of effort in each fishery stratum i (B_i) was estimated as:

$$\hat{B}_i = \sum_{j=1}^{4} N_{ij} 2\bar{b}_{ij}, \qquad (1)$$

where:

$\bar{b}_{ij}$ = the mean number of boats returning during one-half of period j in stratum i, and

N_{ij} = the total number of sample units (3.5-hour time periods) possible during period j in stratum i.

The variance of $\hat{B}_i$ was estimated as (Schaeffer et al. 1979):

$$V(\hat{B}_i) = \sum_{j=1}^{4} 4N^2_{ij} \, [s^2_{ij}/n_{ij}][1-(n_{ij}/N_{ij})] \, , \qquad (2)$$

where:

N_{ij} is defined as above,

n_{ij} = the total number of sample units surveyed during period j in fishery stratum i, and

s^2_{ij} = the sample variance for the mean number of boats returning during period j in fishery stratum i.

The total number of boat trips for the Valdez Arm fishery was estimated by summing the estimates for each stratum for all segments of the fishery. These are considered independent estimates and the estimated variance of the total is the sum of the variances.

Harvest per unit effort was estimated as mean harvest per boat trip for each stratum in each fishery segment. Mean harvest per unit effort for stratum i (HPB_i) was calculated as:

$$\overline{HPB}_i = \left(\sum_{k=1}^{t_i} h_{ik}\right)/t_i \, , \qquad (3)$$

where:

t_i = the total number of boats interviewed during stratum i, and

h_{ik} = the harvest of coho salmon, pink salmon, and halibut by boat k interviewed during stratum i.

The variance of $\overline{HPB}_i$ was estimated by a two-stage sampling design with days being the first stage sample unit (of which there are a finite number available to be sampled) and boats being the second stage sample unit (of which there are an unknown number available to be sampled on any given day) as follows (Von Geldern and Tomlinson 1973):

$$V(\overline{HPB}_i) = [1 - d_i/D_i)]\ s_B^2/d_i + (\sum_{j=1}^{d_i} s_{ij}^2/m_{ij})/d_iD_i \ , \qquad (4)$$

where:

d_i = the number of days in stratum i during which interviews were conducted,

D_i = the total number of days in stratum i,

s_B^2 = the between-day variance of $\overline{HPB}_i$ in stratum i,

s_{ij}^2 = the sample variance of $\overline{HPB}_{ij}$ on day j in stratum i, and

m_{ij} = the number of boats interviewed during day j of stratum i.

Between-day variance was calculated as:

$$s_B^2 = [\sum_{i=1}^{d_i} (\overline{HPB}_{ij} - \overline{HPB}_i)^2]/(d_i-1) \ . \qquad (5)$$

The number of coho and pink salmon and halibut harvested during the weekday or weekend/holiday stratum of each fishery segment (H_i) was calculated as follows:

$$\hat{H}_i = \hat{B}_i\overline{HPB}_i \ . \qquad (6)$$

The variance of $\hat{H}_i$ was estimated using the formula for the product of two independent random variables (Goodman 1960):

$$V(\hat{H}_i) = [\hat{B}_i^2\ V(\overline{HPB}_i)] + [\overline{HPB}_i^2\ V(\hat{B}_i)] - [V(\hat{B}_i)\ V(\overline{HPB}_i)] \ . \qquad (7)$$

The total harvest of coho and pink salmon and halibut by all segments of the boat fishery (H_T) was estimated as follows:

$$\hat{H}_T = \sum_{i=1}^{6} \hat{H}_i \qquad (8)$$

where i is one of four fishery strata. Because these are independent estimates, the estimated variance of the total is the sum of the variances.

The catch per unit effort and total catch of halibut were estimated by substituting the numbers of halibut caught for the numbers of halibut harvested in equations 3 through 8.

Assumptions necessary for these analyses are:

1. Interviewed boat anglers were representative of the total population of boat anglers.
2. No significant fishing effort occurred between 2200 and 0800 hours.
3. Counts of boats and catch and harvest per boat are normally distributed random variables.

Shore Fishery:

A roving creel survey (Neuhold and Lu 1957) was used to count anglers and conduct angler interviews at the Allison Point and Valdez breakwater beaches. The creel survey followed a stratified random sampling design. Days were stratified into four 3.5-hour periods (A: 0800-1130 hrs, B: 1131-1500 hrs, C: 1501-1830 hrs, and D: 1831-2200 hrs). One 3.5-hour sample unit was randomly selected, without replacement, within each day the Valdez boat fishery was sampled. The period to be sampled was randomly selected from one of the two periods not sampled in the boat fishery. Since two beaches were surveyed, 1.5 hours was spent at each beach. The beaches were surveyed in a random order which was determined prior to each sample period. Because this was a newly surveyed fishery and use patterns had not been established, allocation of sampling effort was evenly distributed among the four periods.

Counts of anglers were used to estimate fishing effort in units of angler-hours and interviews of anglers were used to estimate the harvest rates (number of fish per hour) of coho and pink salmon. Counts of all anglers actively fishing were conducted during a randomly selected 15 minute interval during each sampling period and were considered instantaneous. Interviews of shore anglers were conducted during the time remaining in each sampling period. For each shore angler interviewed, the following information was obtained:

1. the number of hours fished,
2. the number of coho and pink salmon harvested, and
3. whether the interview was a completed-trip interview or not (whenever possible, completed-trip interviews were obtained).

The total number of angler-hours of fishing effort ($\hat{E}_i$) for fishery stratum i in the shore fishery was calculated in the following manner:

$$\hat{E}_i = \sum_{j=1}^{4} H_{ij}\bar{x}_{ij} \quad , \tag{9}$$

where:

$\bar{x}_{ij}$ = the mean number of anglers for counts during period j in stratum i, and

H_{ij} = the total number of sample units (3.5-hour time periods) possible during period j in stratum i.

The variance for the estimate of total effort was calculated as:

$$\hat{V}(E_i) = \sum_{j=1}^{4} H^2_{ij}\, s^2_{ij}/n_{ij} \quad , \tag{10}$$

where:

n_{ij} = the total number of angler counts during period j in fishery stratum i, and

s^2_{ij} = the sample variance for x_{ij}.

Harvest per unit effort (harvest per angler-hour, HPUE) was estimated for each stratum in the following manner:

$$HPUE_i = \sum_{k=1}^{m_i} h_{ik} / \sum_{k=1}^{m_i} e_{ik} \quad , \tag{11}$$

where:

m_i = the number of anglers interviewed during stratum i,

h_{ik} = the harvest of coho and pink salmon by angler k interviewed during stratum i, and

e_{ik} = the effort (number of hours expended) by angler k at the time of the interview.

Omitting the finite population correction factor, the variance of $HPUE_i$ was approximated as (Jessen 1978):

$$\hat{V}(HPUE_i) \approx (\bar{C}_i/\bar{E}_i)^2 \left[s^2_C/\bar{C}_i^2 + s^2_E/\bar{E}_i^2 - (2r_i s_C s_E/\bar{C}_i\bar{E}_i)\right] \quad , \tag{12}$$

where:

$\bar{C}_i$ = the mean harvest of coho and pink salmon by anglers in stratum i,

$\bar{E}_i$ = the mean effort by anglers in stratum i,

s^2_C = the two-stage variance of the mean harvest ($\bar{C}_i$),

s^2_E = the two-stage variance of the mean effort ($\bar{E}_i$), and

r_i = the correlation coefficient for the h_{ik} and e_{ik}.

The total harvest of coho and pink salmon ($\hat{H}_i$) for each stratum of the shore fisheries was calculated by:

$$\hat{H}_i = \hat{E}_i HPUE_i \quad . \tag{13}$$

The variance of $\hat{H}_i$ was estimated using the formula for the product of two random variables from Goodman (1960) provided earlier.

The harvest was estimated for all strata of the shore fisheries and then summed to estimate the total season harvest. These are considered independent estimates, therefore, the estimated variance of the total was the sum of the variances.

The major assumptions for these analyses include:

1. Incomplete-trip angler interviews provide an unbiased estimate of completed-trip HPUE.
2. Harvest rate and length of fishing trip are independent variables.
3. Interviewed anglers are representative of the total angler population and anglers are interviewed in proportion to their abundance.
4. No significant fishing effort occurs between 2200 and 0800 hours.
5. Effort and harvest are normally distributed random variables.

Estimation of Hatchery Contribution to the Fishery:

A portion of the coho salmon observed during the creel surveys were examined for missing adipose fins. Salmon missing an adipose fin were assumed to be a fish originating from a hatchery stocking. Adult coho salmon harvested in the Valdez Arm sport fisheries were expected to return from stockings of 86,255 coho salmon smolts during 1987 of which 10,673 had their adipose fin removed and received a coded microwire tag (CWT) implanted at the hatchery to distinguish their origin. This information was used to estimate the contribution of stocked coho and pink salmon to the 1988 Valdez Arm sport fisheries using the procedures of Clark and Bernard (1987).

Eshamy Creel Survey

A stratified random creel survey was conducted to estimate effort and catch and harvest of sockeye and pink salmon in the Eshamy Lagoon sport fishery from 10 July through 7 September 1988. A roving creel survey (Neuhold and Lu

1957) was used to count anglers and conduct angler interviews. The creel survey followed a stratified random sampling design. The fishery was divided into weekday and weekend/holiday components. The fishing day was 14 hours long and was stratified into four 3.5-hour time periods (A: 0800-1130 hrs, B: 1131-1500 hrs, C: 1501-1830 hrs, and D: 1831-2200 hrs). One 3.5-hour sample unit was randomly selected, without replacement, to sample each day. Because this was a newly surveyed fishery and use patterns had not been established, allocation of sampling effort was evenly distributed among the four periods.

Counts of anglers were used to estimate fishing effort in units of angler-hours and angler interviews were used to estimate catch and harvest rates (number of fish per hour) of sockeye and pink salmon. Counts of all anglers actively fishing were conducted during a randomly selected 15 minute interval during the daily sampling period and were considered instantaneous. Interviews of individual anglers were conducted during the remaining time in each daily sample period. For each angler interviewed, the following information was collected:

1. the number of hours fished,
2. the number of sockeye and pink salmon caught and harvested, and
3. whether the interview was a completed-trip interview or not.

Effort, catch, and harvest and their associated variances were estimated as described for the Valdez Arm shore fishery.

RESULTS

Valdez

Effort and harvest data for the Valdez Arm boat and shore fisheries were divided into two periods. The first period (A) was from 1 July through 5 August and covered the time interval when anglers were targeting primarily on pink salmon. The second period (B) was from 6 August through the end of the surveys (5 September for the boat fishery and 15 September for the shore fishery) and coincided with when the fishery was targeting coho salmon.

Sport Effort:

Boat Fishery. Counts of returning boats during the survey periods ranged from 0 to 96 boats (Appendix Table 1). Most private and charter boats returned during the afternoon and evening sampling periods (1501-1830 hrs and 1831-2200 hrs, respectively). Estimated effort during the survey was 4,062 boat-trips (Table 1). Boat effort during the coho salmon fishery (period B) accounted for 61.7% of the total boat effort during the survey. Of the total boat parties interviewed, 34.1% were targeting bottomfish of which 21.9% were chartered (Table 2). Guided boats averaged five anglers per boat while unguided boats averaged three anglers per boat.

Shore Fishery. Counts of anglers during the survey periods ranged from 0 to 103 shore anglers (Appendix Table 2). Most shore anglers fished during the

Table 1. Estimated sport effort (boat-trips), harvest rate (harvest per boat-trip), and harvest of coho salmon by boat anglers in Valdez Arm during 1988.

Strata	Effort	Standard Error	Harvest Rate	Standard Error	Harvest	Standard Error	95% Confidence Interval
PERIOD A							
1 JULY - 5 AUGUST							
Weekdays	761	85	0.10	0.07	75	57	(36)- 187
Weekends	793	127	0.05	0.02	43	15	13 - 73
All Days	1,554	152	0.08	0.08	118	59	3 - 233
PERIOD B							
6 AUGUST - 5 SEPTEMBER							
Weekdays	1,289	143	3.18	0.59	4,100	879	2,378 - 5,823
Weekends	1,219	167	2.23	0.36	2,718	576	1,589 - 3,847
All Days	2,508	220	2.72	0.69	6,818	1,051	4,759 - 8,878

Table 2. Catch and harvest rates (fish per boat-trip), catch (fish kept plus fish released), and harvest (fish kept only) of halibut and coho and pink salmon by angler type in the boat fishery in Valdez Arm during 1988.

			Halibut				Coho		Pink	
BOAT ANGLER TYPE	Number of Interviews	Number of Anglers	Harvest Rate	Kept	Catch Rate	Released	Harvest Rate	Kept	Harvest Rate	Kept
Guided Targeting Bottomfish	37	225	8.2	305	13.2	184	0.0	0	0.7	25
Unguided Targeting Bottomfish	132	465	1.6	205	2.5	121	0.3	42	1.3	175
Guided Targeting Salmon	46	204	0.0	0	0.0	0	3.4	157	5.2	239
Unguided Targeting Salmon	271	865	0.1	13	0.1	4	1.9	522	2.5	665
All Boat Anglers Combined	486	1,759	1.1	523	1.7	309	1.5	721	2.3	1,104

afternoon and evening survey periods. Estimated angler-effort during the survey was 33,187 angler-hours with the highest effort recorded during the weekdays (Table 3). Most of the shore angler effort (77.9%) was recorded during the pink salmon fishery (period A).

Harvest and Catch Rates:

Boat Fishery. The mean harvest rate of coho salmon for boat anglers for periods A and B were 0.08 and 2.72 fish per boat-trip, respectively (Table 1). Harvest rates for boat anglers were higher during weekdays during both periods. For pink salmon, the mean harvest rate for boat anglers was 4.58 during period A and 0.26 during period B (Table 4). Mean harvest rates for halibut were 1.36 and 0.71 fish per boat-trip during periods A and B, respectively (Table 5). Catch rates for halibut averaged 2.36 fish per boat trip during period A and 1.00 fish per boat trip during period B. Harvest rates for coho salmon, pink salmon, and halibut were higher for guided boat anglers than unguided boat anglers during the 1988 survey (Table 6). Guided boat anglers which were targeting bottomfish averaged 8.2 halibut per boat-trip while unguided boat anglers averaged 1.6 halibut per boat-trip (Table 2). Similarly, guided boat anglers targeting salmon averaged more than twice the number of salmon per boat-trip than did unguided anglers.

Shore Fishery. The mean harvest rate of coho salmon for shore anglers for periods A and B was 0.01 and 0.18 fish per angler-hour, respectively (Table 3). For pink salmon, the mean harvest rate for shore anglers was 0.48 during period A and 0.00 during period B (Table 7). No halibut were reported caught by shore anglers during the survey.

Harvest and Catch:

Boat Fishery. The estimated harvest of coho salmon in the Valdez Arm boat fishery was 6,936 fish, of which 98.3% (6,818 fish) were harvested during period B (Table 1). Conversely, of the estimated 7,774 pink salmon harvested by boat anglers, 91.6% (7,119 fish) were taken during period A (Table 4). An estimated 3,887 halibut were harvested by boat anglers with 54.3% of the harvest occurring during period A (Table 5). An additional 2,293 halibut (37.1% of the total catch) which were caught by anglers were released. Boat anglers which were targeting bottomfish accounted for 97.5% of the total halibut harvest, with guided boat anglers accounting for 59.8% of this harvest (Table 2). Similarly, boat anglers targeting salmon accounted for 81.9% of the total salmon harvest in the boat fishery.

Shore Fishery. The estimated harvest of coho salmon in the shore fishery was 1,514 fish of which 85.7% (1,297 fish) were harvested during period B (Table 2). Shore anglers accounted for only 17.9% of the total estimated harvest of coho salmon during the 1988 Valdez Arm survey. For pink salmon, the estimated harvest in the shore fishery was 12,393 fish which were all taken during period A (Table 4). Shore anglers accounted for 61.5% of the total estimated pink salmon harvest in Valdez Arm during 1988.

Table 3. Estimated sport effort (angler-hours), harvest rate (harvest per angler-hour), and harvest of coho salmon by shore anglers in Valdez Arm during 1988.

Strata	Effort	Standard Error	Harvest Rate	Standard Error	Harvest	Standard Error	95% Confidence Interval
PERIOD A							
1 JULY - 5 AUGUST							
Weekdays	17,243	2,862	0.01	0.004	183	82	22 - 343
Weekends	8,624	1,286	0.01	0.002	34	16	3 - 66
All Days	25,867	3,138	0.01	0.005	217	84	54 - 381
PERIOD B							
6 AUGUST - 5 SEPTEMBER							
Weekdays	4,758	1,598	0.20	0.044	944	373	212 - 1,675
Weekends	2,562	956	0.14	0.023	353	142	74 - 631
All Days	7,320	1,862	0.18	0.049	1,297	399	514 - 2,079

Table 4. Estimated sport effort (boat-trips), harvest rate (harvest per boat-trip), and harvest of pink salmon by boat anglers in Valdez Arm during 1988.

Strata	Effort	Standard Error	Harvest Rate	Standard Error	Harvest	Standard Error	95% Confidence Interval
PERIOD A							
1 JULY - 5 AUGUST							
Weekdays	761	85	5.01	1.27	3,813	1,051	1,753 - 5,873
Weekends	793	127	4.17	0.59	3,306	703	1,928 - 4,684
All Days	1,554	152	4.58	1.40	7,119	1,264	4,641 - 9,598
PERIOD B							
6 AUGUST - 5 SEPTEMBER							
Weekdays	1,289	143	0.23	0.10	300	130	46 - 555
Weekends	1,219	167	0.29	0.07	355	102	155 - 555
All Days	2,508	220	0.26	0.12	655	165	331 - 979

Table 5. Estimated sport effort (boat-trips), harvest and catch rates (fish per boat-trip), and harvest and catch of halibut by boat anglers in Valdez Arm during 1988.

Strata	Effort	Standard Error	Harvest Rate	Standard Error	Harvest	Standard Error	95% Confidence Interval	Catch Rate	Standard Error	Harvest	Standard Error	95% Confidence Interval
PERIOD A												
1 JULY - 5 AUGUST												
Weekdays	761	85	1.09	0.34	828	273	293 - 1,363	2.21	0.66	1,681	531	640 - 2,723
Weekends	793	127	1.62	0.47	1,281	424	450 - 2,111	2.50	0.66	1,983	608	791 - 3,174
All Days	1,554	152	1.36	0.58	2,109	504	1,121 - 3,097	2.36	1.15	3,664	807	2,081 - 5,246
PERIOD B												
6 AUGUST - 5 SEPTEMBER												
Weekdays	1,289	143	0.64	0.18	822	244	345 - 1,300	0.97	0.29	1,256	403	466 - 2,045
Weekends	1,219	167	0.78	0.25	956	328	312 - 1,599	1.03	0.30	1,260	404	468 - 2,053
All Days	2,508	220	0.71	0.31	1,778	409	977 - 2,580	1.00	0.77	2,516	571	1,397 - 3,635

Table 6. Estimated harvest rates (fish per boat-trip) of coho and pink salmon and halibut by boat anglers in Valdez Arm during 1988.

	COHO SALMON		PINK SALMON		HALIBUT	
	Harvest Rate	Standard Error	Harvest Rate	Standard Error	Harvest Rate	Standard Error
GUIDED						
PERIOD A 1 JULY - 5 AUGUST						
Weekdays	0.26	0.28	6.53	2.86	1.84	0.60
Weekends	0.00	0.00	3.68	1.61	7.00	1.34
All Days	0.13	0.14	5.11	1.59	4.42	1.02
PERIOD B 6 AUGUST - 5 SEPTEMBER						
Weekdays	6.15	2.19	0.00	0.00	2.92	1.49
Weekends	2.55	0.77	0.27	0.11	3.59	1.22
All Days	3.89	1.39	0.17	0.06	3.34	0.95
UNGUIDED						
PERIOD A 1 JULY - 5 AUGUST						
Weekdays	0.06	0.07	4.53	1.34	0.71	0.46
Weekends	0.06	0.02	4.00	0.49	0.85	0.36
All Days	0.06	0.04	4.18	0.72	0.80	0.29
PERIOD B 6 AUGUST - 5 SEPTEMBER						
Weekdays	2.83	0.64	0.27	0.12	0.36	0.09
Weekends	2.12	0.50	0.30	0.08	0.28	0.06
All Days	2.44	0.41	0.29	0.07	0.31	0.06

Table 7. Estimated sport effort (angler-hours), harvest rate (harvest per angler-hour), and harvest of pink salmon by shore anglers in Valdez Arm during 1988.

Strata	Effort	Standard Error	Harvest Rate	Standard Error	Harvest	Standard Error	95% Confidence Interval
PERIOD A							
1 JULY - 5 AUGUST							
Weekdays	17,243	2,862	0.51	0.056	8,773	1,737	5,369 - 12,177
Weekends	8,624	1,286	0.42	0.023	3,620	573	2,497 - 4,744
All Days	25,867	3,138	0.48	0.280	12,393	1,829	8,809 - 15,978
PERIOD B							
6 AUGUST - 5 SEPTEMBER							
Weekdays	4,758	1,598	0.00	0.000	0	---	0 - 0
Weekends	2,562	956	0.00	0.000	0	---	0 - 0
All Days	7,320	1,862	0.00	0.000	0	---	0 - 0

Hatchery Contribution to the Fishery:

Four hundred ninety-two coho salmon were examined during the creel surveys of the boat fishery of which 24 were found to be missing their adipose fins. One hundred coho salmon were examined during the creel surveys of the beach fisheries, of which four were found to be missing their adipose fins. There was not a significant difference in the numbers of fish observed to be with and without an adipose fin in the two fisheries ($P < 0.05$) and thus, the data were grouped. Thus, based on these numbers, an estimated 3,223 (SE = 1090) of the 8,450 coho salmon harvested in the boat and beach fisheries originated from the 1987 stocking of smolts.

Eshamy

Sport Effort:

Counts of anglers during the survey periods ranged from 0 to 19 anglers (Appendix Table 3). Most anglers fished Eshamy Lagoon during the afternoon and evening survey periods. Estimated effort during the survey was 2,572 angler-hours with the highest effort recorded during the weekdays (Table 8).

Harvest and Catch Rates:

The mean harvest and catch rates of sockeye salmon were 0.37 and 0.48 fish per angler-hour, respectively, with the highest rates recorded for the weekdays (Table 8). For pink salmon, the mean harvest and catch rates were 0.03 and 0.85 fish per angler-hour, respectively.

Harvest and Catch:

The estimated catch of sockeye salmon in the Eshamy Lagoon sport fishery was 1,238 fish of which 77.5% (959 fish) were harvested (Table 8). Anglers harvested 84.0% and 65.6% of the total sockeye salmon catch during the weekdays and weekends, respectively. The estimated pink salmon catch during the survey was 2,190 fish of which only 3.7% (82 fish) were harvested (Table 8). Anglers fishing during the weekdays accounted for 80.5% and 61.3% of the total harvest and catch, respectively.

DISCUSSION

Valdez

The estimated sport harvest of 8,450 coho salmon in 1988 falls at the high end of the range of sport harvests estimated for Valdez Arm by the statewide harvest survey for the past 3 years (Mills 1986-1988). The boat fishery accounted for a larger percentage of the total harvest in 1988 (Figure 9) than in previous years with most of the harvest taking place during the period from 6 August through 5 September. The estimated pink salmon harvest of 20,167 fish during 1988 was approximately 25% lower than the average estimated harvest for 1985 through 1987 (Mills 1986-1988). This was due in part to a substantial reduction in the estimated 1988 pink salmon harvest by boat

Table 8. Estimated sport effort (angler-hours), harvest and catch rates (fish per boat-trip), and harvest and catch of sockeye and pink salmon by boat anglers at Eshamy during 1988.

Strata	Effort	Standard Error	Harvest Rate	Standard Error	Harvest	Standard Error	95% Confidence Interval	Catch Rate	Standard Error	Harvest	Standard Error	95% Confidence Interval
SOCKEYE SALMON												
Weekdays	1,552	328	0.43	0.06	671	168	341 - 1,002	0.51	0.06	799	191	424 - 1,173
Weekends	1,020	312	0.28	0.08	288	115	62 - 514	0.43	0.12	439	177	93 - 785
All Days	2,572	453	0.37	0.10	959	204	559 - 1,359	0.48	0.13	1,238	260	728 - 1,748
PINK SALMON												
Weekdays	1,552	328	0.04	0.02	66	34	(1)- 133	0.87	0.14	1,343	353	651 - 2,035
Weekends	1,020	312	0.02	0.01	16	9	(2)- 34	0.83	0.22	847	337	187 - 1,508
All Days	2,572	453	0.03	0.02	82	35	12 - 151	0.85	0.26	2,190	488	1,233 - 3,147

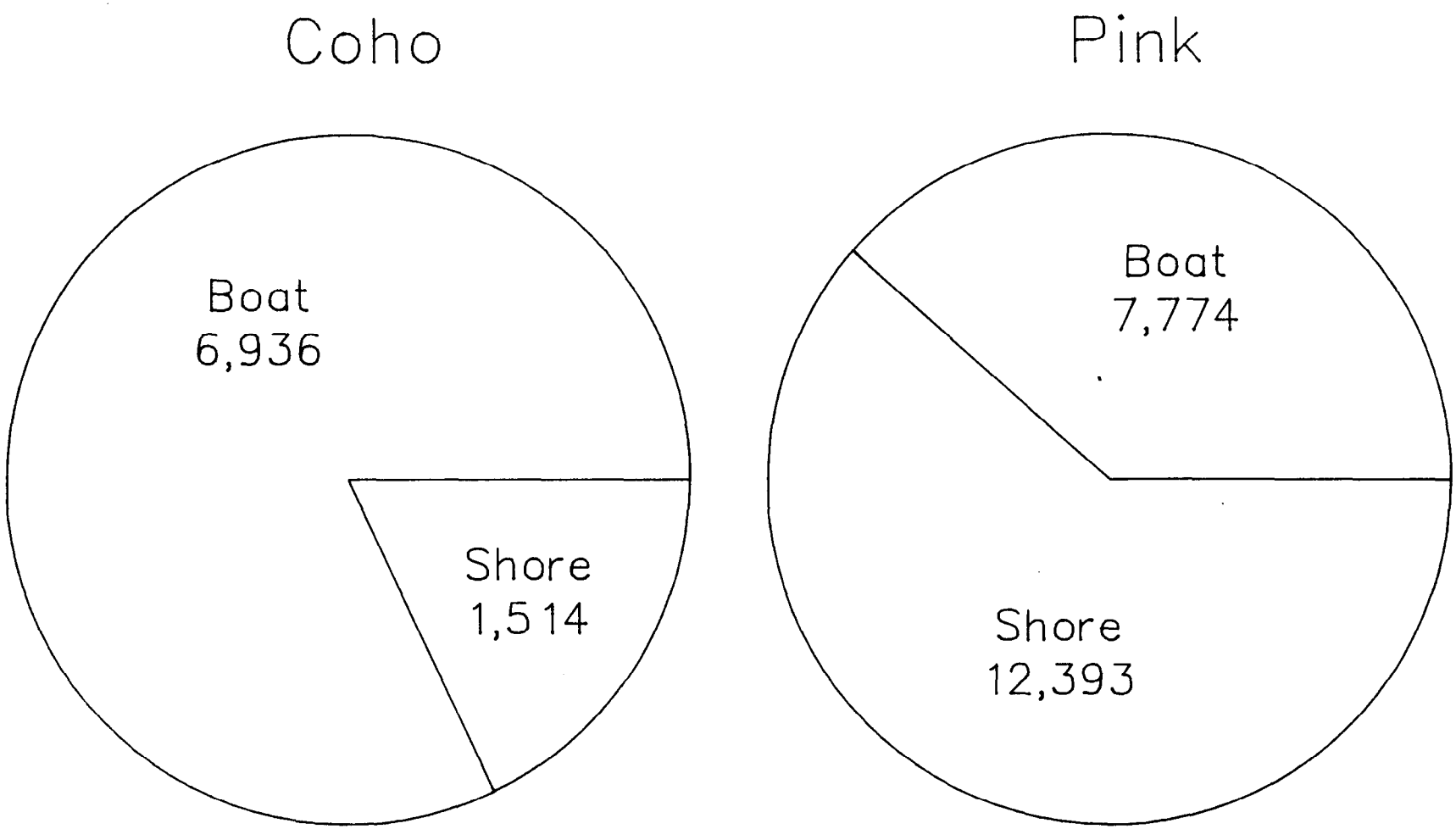

Figure 9. Coho and pink salmon sport harvest by boat and shore anglers in Valdez Arm during 1988.

anglers. Essentially all of the pink salmon harvest took place from 1 July through 5 August. Salmon harvest rates for guided boat anglers were substantially higher than the rates for unguided anglers throughout the survey.

The estimated harvest of 3,887 halibut during the 1988 survey is the highest sport harvest on record. The largest percentage of the halibut harvest was by charter boats which fished the waters outside of Valdez Arm in the areas around Port Fidalgo, Port Gravina, Orca Bay, and Hinchinbrook Island. For boats targeting bottomfish, guided boats had harvest rates five times higher than those of unguided boats. Boat anglers fishing specifically for bottomfish released 37.4% of the halibut they caught.

Coho and pink salmon harvest in Valdez Arm is expected to continue to increase through the continued stocking efforts by VFDA's Solomon Gulch Hatchery. During 1988, an estimated 38% of the coho salmon harvested in the boat and beach fisheries originated from the 1987 stocking of smolts. In addition, the Board of Fisheries has opened the streams entering Valdez Arm and the surrounding waters to salmon fishing beginning in 1989. Given this, we recommend the creel survey be continued in 1989 to assess the influence these regulation changes have on the sport fisheries in Valdez Arm. It is also necessary to determine the hatchery contribution to the pink and coho salmon fisheries and provide the data necessary to protect the area's natural stocks. With the high incidence of catch-and release in the halibut sport fishery, coupled with the reduction in bag and possession limits for rockfish in PWS, future surveys should include data collection efforts on these bottomfish stocks. The sampling periods for future creel surveys in Valdez Arm should be adjusted to adequately sample the later daily periods when the highest levels of fishing activity are occurring.

Eshamy

Sockeye salmon escapement to Eshamy Lake during 1988 was approximately 32,000 fish (Brady et al. 1988). The estimated sport harvest during the 1988 survey of 959 sockeye is higher than the average annual sport harvest since 1980, but it represents only 3.0% of the total return to Eshamy in 1988. Comparatively, the commercial harvest of sockeye salmon in the Eshamy District during 1988 was approximately 60,000 fish.

It is likely that actions will be taken in the commercial fisheries during 1989 to insure an escapement of 30,000 to 40,000 sockeye salmon into Eshamy Lake. Given this, the Board of Fisheries reduced the bag and possession limits for sockeye salmon in the Eshamy system from six fish daily, 12 in possession to three fish daily, six in possession in 1989 in an effort to further assure an adequate escapement of sockeye. In addition, Main Bay Hatchery, located in Main Bay just north of Eshamy, was converted to a sockeye salmon facility in 1987. Returns from hatchery releases are projected to create terminal area sport fisheries in Main Bay and in six other remote locations in PWS. If the current strategy used to manage Eshamy Lagoon is applied to these developing locations, sport fishermen are not likely to participate substantially in the harvest. It is necessary to monitor the Eshamy sport fishery to develop a suitable terminal area management strategy for sockeye salmon in PWS. Given these factors, we

recommend the creel survey at Eshamy be continued during 1989 to monitor the effects of the regulation change and provide an inseason estimate of the sport harvest to maximize angling opportunities while providing the data necessary to effectively manage this fishery.

ACKNOWLEDGEMENTS

We would like to thank Thomas Cappiello who collected the Valdez Arm field data, Steve Ehrman and Robin Irving who collected the Eshamy Lagoon data, and Doug Vincent-Lang who assisted in the design of the operational plan and the data analyses.

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APPENDIX

Appendix Table 1. Counts of boats during the Valdez Arm sport fishery during 1988.

Date		Period A	Period B	Period C	Period D
01-Jul		--		--	
02-Jul		0	5		
03-Jul		0			33
04-Jul			12	22	
05-Jul		5	10		
06-Jul	OFF				
07-Jul	OFF				
08-Jul		0		15	
09-Jul				16	5
10-Jul		1	12		
11-Jul				11	6
12-Jul			4		16
13-Jul		2		14	
14-Jul	OFF				
15-Jul	OFF				
16-Jul			10		64
17-Jul		4	22		
18-Jul	OFF				
19-Jul	OFF				
20-Jul		0			16
21-Jul		4			4
22-Jul			4		8
23-Jul			10		30
24-Jul		0		28	
25-Jul				8	8
26-Jul			8		12
27-Jul	OFF				
28-Jul	OFF				
29-Jul			14	4	
30-Jul		4		32	
31-Jul		4	18		
01-Aug	OFF				
02-Aug	OFF				
03-Aug		0			16
04-Aug		0	8		
05-Aug			0		30
06-Aug				30	12
07-Aug		6	22		
08-Aug			18		32
09-Aug		0		24	
10-Aug			4	30	

-Continued-

Appendix Table 1. Counts of boats during the Valdez Arm sport fishery during 1988 (continued).

Date	Period A	Period B	Period C	Period D
11-Aug OFF				
12-Aug OFF				
13-Aug	0			56
14-Aug		56	96	
15-Aug			40	22
16-Aug			40	22
17-Aug OFF				
18-Aug OFF				
19-Aug	6			50
20-Aug			50	90
21-Aug			62	36
22-Aug OFF				
23-Aug OFF				
24-Aug	10	8		
25-Aug		12	28	
26-Aug			14	14
27-Aug		14	26	
28-Aug		12		50
29-Aug OFF				
30-Aug OFF				
31-Aug	0		16	
01-Sep		--	--	
02-Sep	2	2		
03-Sep			18	22
04-Sep	8		14	
05-Sep			32	8
Mean Angler Count	2.5	12.4	27.9	26.5

-- No count conducted.

Appendix Table 2. Counts of shore anglers during the Valdez Arm sport fishery during 1988.

Date	Period A	B	C	D
01-Jul				40
02-Jul				63
03-Jul			103	
04-Jul				57
05-Jul				93
06-Jul OFF				
07-Jul OFF				
08-Jul				81
09-Jul	68			
10-Jul				75
11-Jul	77			
12-Jul	38			
13-Jul				87
14-Jul OFF				
15-Jul OFF				
16-Jul	61			
17-Jul			46	
18-Jul OFF				
19-Jul OFF				
20-Jul			102	
21-Jul		17		
22-Jul			59	
23-Jul	0			
24-Jul				17
25-Jul		32		
26-Jul	9			
27-Jul OFF				
28-Jul OFF				
29-Jul	17			
30-Jul		67		
31-Jul			59	
01-Aug OFF				
02-Aug OFF				
03-Aug			17	
04-Aug			49	
05-Aug			21	
06-Aug		0		
07-Aug			4	
08-Aug			19	
09-Aug				8
10-Aug				6

-Continued-

Appendix Table 2. Counts of shore anglers during the Valdez Arm sport fishery during 1988 (continued).

Date		Period A	B	C	D
11-Aug	OFF				
12-Aug	OFF				
13-Aug				14	
14-Aug		5			
15-Aug		14			
16-Aug			12		
17-Aug	OFF				
18-Aug	OFF				
19-Aug				76	
20-Aug		69			
21-Aug		34			
22-Aug	OFF				
23-Aug	OFF				
24-Aug				2	
25-Aug					0
26-Aug			20		
27-Aug					0
28-Aug				12	
29-Aug	OFF				
30-Aug	OFF				
31-Aug			11		
01-Sep		2			
02-Sep					14
03-Sep			4		
04-Sep			13		
05-Sep			15		
06-Sep			9		
07-Sep		3			
08-Sep	OFF				
09-Sep	OFF				
10-Sep					0
11-Sep			13		
12-Sep			9		
13-Sep			9		
14-Sep		0			
15-Sep	OFF				
Mean Angler Count		28.4	16.5	41.6	38.6

Appendix Table 3. Counts of anglers during the Eshamy Lagoon sport fishery during 1988.

Date	Period A	B	C	D
10-Jul		0		
11-Jul			0	
12-Jul	0			
13-Jul			4	
14-Jul			3	
15-Jul	0			
16-Jul			10	
17-Jul		5		
18-Jul			4	
19-Jul			5	
20-Jul				3
21-Jul	0			
22-Jul				2
23-Jul			0	
24-Jul				9
25-Jul				0
26-Jul				--
27-Jul	0			
28-Jul			5	
29-Jul			0	
30-Jul				19
31-Jul	0			
01-Aug	4			
02-Aug		0		
03-Aug			10	
04-Aug				11
05-Aug		0		
06-Aug		0		
07-Aug		4		
08-Aug				0
09-Aug			11	
10-Aug		0		
11-Aug		3		
12-Aug				11
13-Aug			8	
14-Aug			7	
15-Aug	4			
16-Aug				14
17-Aug			6	
18-Aug		5		
19-Aug	3			

-Continued-

Appendix Table 3. Counts of anglers during the Eshamy Lagoon sport fishery during 1988 (continued).

Date	Period A	B	C	D
20-Aug		3		
21-Aug				0
22-Aug				0
23-Aug	0			
24-Aug		3		
25-Aug		0		
26-Aug				0
27-Aug			0	
28-Aug	0			
29-Aug			6	
30-Aug			0	
31-Aug			0	
01-Sep		0		
02-Sep				0
03-Sep	0			
04-Sep				4
05-Sep		2		
06-Sep			0	
07-Sep		0		
Mean Angler Count	1.0	1.7	9.9	5.2

-- No count conducted.